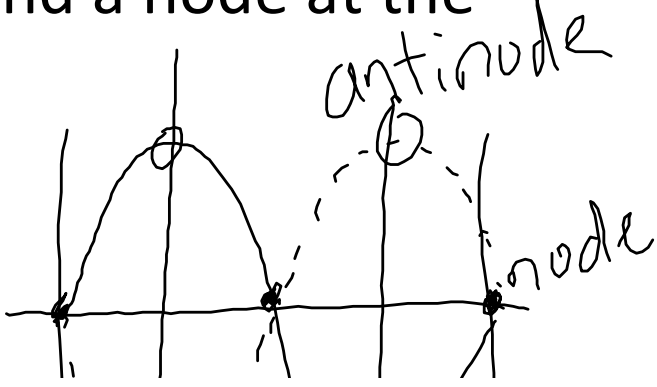
The Sound of Music!

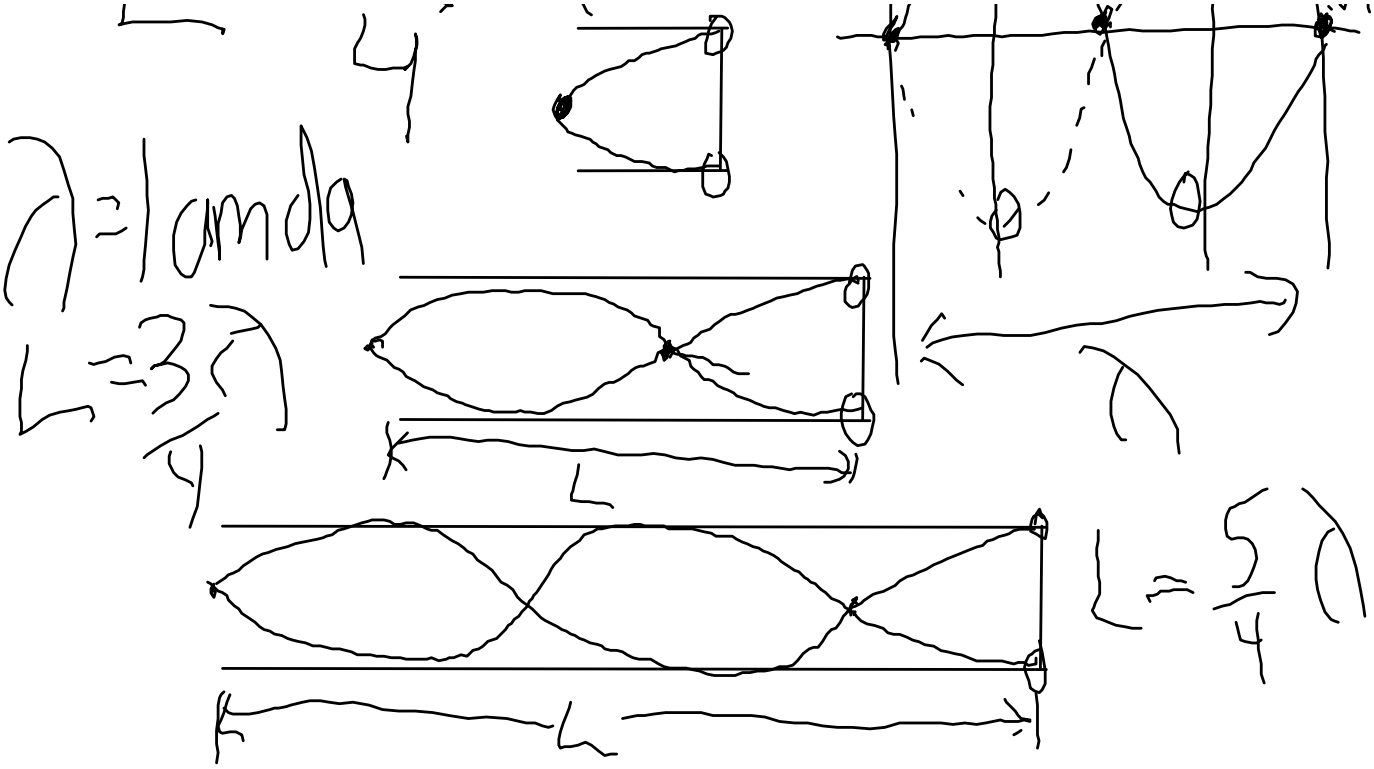
Thursday, April 06, 2017 11:44 AM

Why do we hear the ocean in a sea shell?

Closed-pipe resonator

This is a resonating tube with one end closed. It will resonate when there is an antinode at the closed end and a node at the open end.





Resonant spacing is the spacing between two resonant frequencies.

Ex: Between the first and second resonant frequencies for the closed-piped resonator

$$\frac{3}{4}\lambda - \frac{1}{4}\lambda = \frac{\lambda}{2}$$

$$\frac{5}{4}\lambda - \frac{3}{4}\lambda = \frac{\lambda}{2}$$

Experiment! Let's Calculate the speed of sound in our classroom!!

Theory:

$$v = \lambda f$$

$f = 392\ Hz$

$$L = \frac{\lambda}{4}$$

$\lambda = 4L$

Initial Guess:

343

$(4L)$

Theoretical calculation of the length for the first resonance frequency in our resonance tube:

$$v = \lambda f$$

$343 m/s = (4L)392\ Hz$

$$\frac{343\ m/s}{4(392)\ Hz} = L = 0.219\ m$$

$$219\ cm$$

Data and observations:

Frequency of tuning fork: 392 Hz

Length for first resonance: 20.3 cm

Calculate the velocity:

$v = \lambda f$

$L = \frac{\lambda}{4}$ $\lambda = 4L$

$v = 4Lf$

$v = 4Lf$

$318 = v = 4(0.203)392\,H$

$\left[\frac{3\lambda}{4} + x\right] - \left[\frac{\lambda}{4} + x\right] = \frac{1}{2}\lambda$ (end correction)

Length for second resonance: 64.0 cm

Frequency of tuning fork:

1st 20.3 cm

2nd 64.0 cm

$L = \frac{\lambda}{2}$ $2L = \lambda$

$f = 392$

$v = \lambda f$

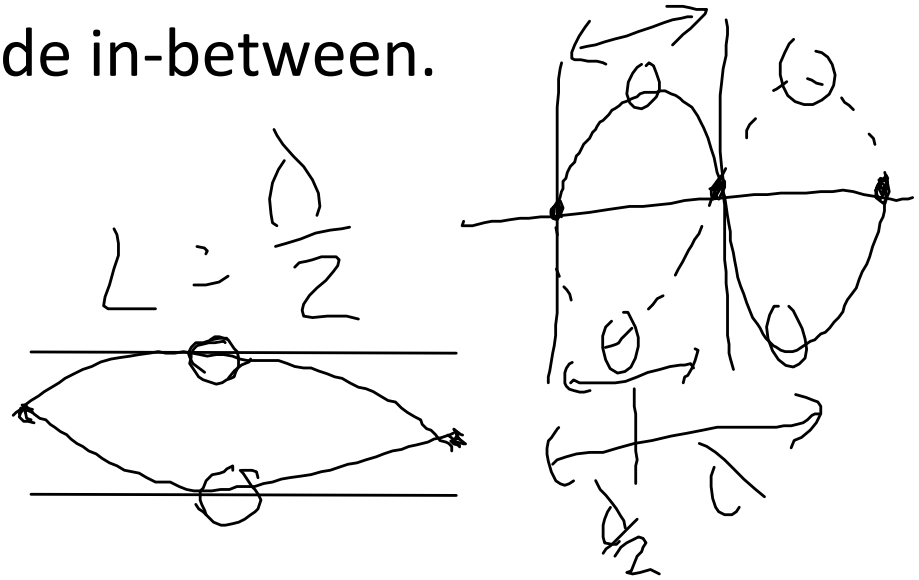
$v = \lambda f = (2L) f$

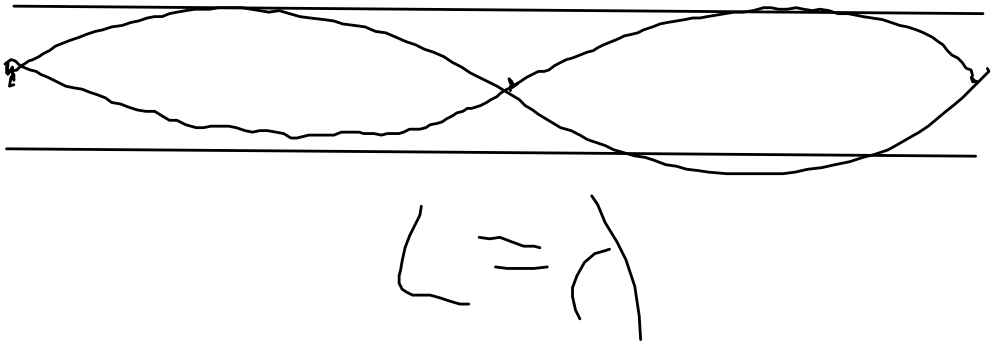
$(2(.640 - .203)(392)$

$= 343 m/s$

Open-piped resonator

A resonating tube with both ends open. An open-piped resonator will resonate when there are pressure nodes near each of the ends, and at least one antinode in-between.





Question: A trumpet can be thought of as an open pipe-resonator. If a trumpet were straightened out, it would be 1.37 m long.

a) If the speed of sound is 343 m/s, find the lowest

frequency that is resonant in a trumpet (ignore end corrections).

b) Find the next higher resonant frequency in the trumpet.